NOTES ON THE CHROMOSOME MORPHOLOGY OF THE GENUS GIBBAEUM HAW.

By Miriam P. de Vos.

Before his death, Professor G. C. Nel was working on a systematic revision of the genus Gibbaeum Haw. and had already visited many of the type localities to collect specimens which he brought to the Botanic Gardens of the University of Stellenbosch for cultivation. The Gibbaeum collection in the garden is now almost complete, nearly all the described species being represented. Professor Nel was of opinion that a knowledge of the incidence of polyploidy might be helpful in elucidating some of the taxonomic problems in the genus. Such an investigation has already been done by Wulff (1944) who studied the chromosome morphology of a large number of Gibbaeum species from the Botanic Gardens of Kiel. But Wulff does not state for what length of time the specimens used by him have been cultivated; and as there is a slight possibility that plants may become polyploid under cultivation, Nel thought that the specimens in the Stellenbosch garden should be used for reinvestigating the occurrence of polyploidy in the genus. Many of these specimens are the original ones collected by him from the type localities and other habitats. Furthermore, the collection in this garden offers a good opportunity for studying the occurrence of intraspecific polyploidy, as some of the species, e.g. *G. cryptopodium*, are represented by material collected from different localities.

In view of such considerations the present author therefore undertook the work of reinvestigating the occurrence of polyploidy in the genus.

Actively growing root-tips were obtained from slips placed in vermiculite for some weeks. The author's thanks are due to Mr. H. Herre and Mr. H. Meyer of the Stellenbosch Gardens for supplying the material. The root-tips were fixed in 2BE and transverse sections, cut 10μ in thickness, were stained with Heidenhain's iron-alum haematoxylin. As many root-tips as possible were examined from each species, to prevent confusing local somatic polyploidy with generative polyploidy.

The results are tabulated below, the diploid species being given first.

In this investigation mitotic divisions in 20 Gibbaeum species have been examined. The large majority of species was found to be diploid, 4 tetraploids being found and only one hexaploid occurring. The chromosome numbers of the four species *G. blackburnii*, *G. cryptopodium*, *G helmiae* and *G. fissoides* and of the *Muirio-Gibbaeum* hybrid are now

Name of Plant.	2x Chromosome Number.	Locality.
Gibbaeum album N.E.Br.	18	Locality unknown
G. blackburnii L. Bolus	18	Calitzdorp, Oudtshoorn Div.
G. comptonii L. Bolus	18	Perdefontein, Montagu Div.
,,	18	Klein Swartberg, Ladismith Div.
G. cryptopodium (Kensit) L. Bolus	18	Witvlak, 21 mls. from Ladismith
,,	18	Ockertskraal, Ladismith Div.
,,	18	Immelman's farm, Ladismith Div.
,,	18	Calitzdorp, Oudtshoorn Div.
,,	18	Road to Barrydale, Ladismith Div.
,,	18	Rooihoogte, Ladismith Div.
G. dispar N.E.Br.	18	Van Wyksdorp, Ladismith Div.
G. fissoides (Haw.) Schwant.	18	30 mls. from Warmbad, Swellendam Div.
,,	18	Allemorgens, Montagu Div.
,,	18	Immelman's farm, Ladismith Div.
G. heathii (N.E.Br.) L. Bolus	18	Calitzdorp
,,	18	Algewynskraal, Ladismith Div.
,,	18	Stofkraalnek, Ladismith Div.
,,	18	Warmbad, Swellendam Div.
,,	18	21 mls. from Ladismith
,, var. major L. Bol.	18	Ockertskraal, Ladismith Div.
G. helmiae L. Bolus	18	Zebra, George Div.
G. luckhoffii L. Bolus	18	Perdefontein, Klein Karroo
G. nebrownii (N.E.Br.) Tisch.	18	Habitat unknown
G. pachypodium (Kensit) L. Bolus	18, 36	Ockertskraal, Ladismith Div.
G. perviride (Haw.) N.E.Br.	18	Immelman's farm, Ladismith Div.
,,	18	Touwsriver, Worcester Div.
,,	18	Ratelfontein, Swellendam Div.
G. petrense (N.E.Br.) Tisch.	18	Springfontein, Riversdale Div.
G. pilosulum N.E.Br.	18	Barrydale rd., 15 mls. from Ladismith
G. pubescens (Haw.) N.E.Br.*	18	Lemoenhoek, Swellendam Div.
,,	18	Allemorgens, Montagu Div.

*These species have also been investigated before by the present author (1947).

Name of Plant.	2x Chromosome Number.	Locality.
G. angulipes (L. Bolus) N.E.Br.	36	Habitat unknown
G. geminum N.E.Br.	36	Bellair Dam, Swellendam Div.
,,	ca. 54	Road to Barrydale, Ladismith Div.
,,	ca. 54	Klein Karroo
G. schwantesii (N.E.Br.) Tisch.*	36	Fisantefontein, Riversdale Div.
G. shandii N.E.Br.	36	8 mls. from Warmbad, Swellendam Div.
G. velutinum (L. Bol.) Schwant.*	36	Habitat unknown
× Muirio-Gibbaeum sp. N.E.Br. (Gibbaeum album(?) × Muiria hortenseae N.E.Br.	18	Springfontein, Riversdale Div.

*These species have also been investigated before by the present author (1947).

recorded for the first time, those of the other species having previously also been studied by Wulff (1944). Together with the latter's results this investigation brings the total number of Gibbaeum species examined for their chromosome morphology up to 23 out of a total of 27 described species (Jacobsen, 1938). (Prof. Nel thought that some of the abovementioned species should be united. For the present the old specific names have been used, as enumerated by Jacobsen.)

Both Wulff's and the present results show that there is a remarkably low percentage of polyploid species in the genus, considering the semi-arid conditions under which the plants exist. It is evident that the formation of new species through polyploidy has not taken place to any great extent in the genus. Even the *Muirio-Gibbaeum* specimen which is considered by N. E. Brown to be a hybrid and which could be expected to show polyploidy, is diploid.

The chromosome numbers of 12 species reinvestigated by the present author agree with Wulff's results. In *Gibbaeum geminum*, however, an intraspecific variation in the degree of polyploidy has now been found, plants from two localities being hexaploid and those from a third locality, the Bellair Dam, being tetraploid. Wulff found the Kiel material of *G. geminum* to be hexaploid only. The occurrence of hexaploid and tetraploid individuals indicates two possible modes of origin for the species:

the hexaploid specimens from triploid and the tetraploid ones from diploid parents.

In two other species different chromosome numbers have now been found: in *G. pachypodium* all the root-tips examined except one, proved to be diploid, the exception being tetraploid; and a root-tip of *G. angulipes* showed the tetraploid chromosome number. The latter is the only species where only one root-tip could be obtained for study. Wulff (1944) found the former to be tetraploid and the latter diploid. Apparently, therefore, intraspecific polyploidy occurs in these two species. On the other hand it is possible that the tetraploid root-tips are cases where doubling of the chromosome number had taken place in the root initials in diploid plants. If this is so, the species *G. angulipes* and *G. pachypodium* should be considered as diploid.

The occurrence of tetraploid chromosomal chimaeras in the periblem of some of the diploid root-tips also indicates that there is a tendency in the genus for somatic cells to become polyploid. In *G. fissoides* and *G. heathii* the present investigator found a root-tip with a tetraploid chimaera, the tetraploid sector covering one-quarter to one-third of the periblem in the transverse section. The plerome, however, remains diploid. These tetraploid cells show no somatic pairing of any of the homologous chromosomes. Wulff (1940) also found no pairing in the metaphase of a tetraploid cell in *G. molle*, but in *G. heathii* var. *elevata* L. Bolus and in *G. dispar* he found a high degree of pairing of the homologous chromosomes in the prophasic and metaphasic stages in tetraploid cells. He concludes that such polyploid somatic cells arise from a double longitudinal splitting or "innere Teilung" of the chromosomes, probably before the prophase sets in.

The presence of polyploid chimaeras and polyploid root-tips shows how careful investigators should be when making use of root-tips for determining the existence of generative polyploidy. Large numbers of root-tips should be examined and many cell-divisions in all parts of the root-tip should be observed.

With one exception there seems to be no connection between polyploidy and the size of the leaves in Gibbaeum. At the time when this investigation took place the plants were not in flower. No statement can therefore be made about polyploidy and the size of the flowers or fruits. In some of the polyploids the leaves are large, e.g. in *G. velutinum*, *G. schwantesii* and *G. shandii*, but in others, e.g. the tetraploid and hexaploid individuals of *G. geminum* they are very small. The hexaploid individuals have slightly bigger leaves than the tetraploid specimens of the same species. This is the only instance where any correlation was found to occur between the degree of polyploidy and the leaf size. Many of the diploids have small globose leaves, but others possess large and very succulent leaves, e.g. *G. heathii* var. *major.*

When the root periblem, however, is partly diploid and partly tetraploid, the tetraploid sector is wider than the diploid and the plerome is therefore excentric. This increase in width is caused by the bigger tetraploid cells; the nuclei of these cells also are bigger than those in the diploid parts.

Wulff (1944) also found no correlation between polyploidy and leaf size, but he observed a correlation between tetraploidy and the degree of succulence, the tetraploids being more succulent than those diploids closely related to them. He states that *G. shandii* is more succulent than the closely related diploid *G. pubescens* and that *G. luteoviride* is more succulent than *G. perviride.* The material in the Stellenbosch garden hardly verifies this: the specimens of *G. luteoviride* and *G. perviride* here show the same degree of succulence and those of *G. shandii* are only slightly more succulent than *G. pubescens. G. haagei* which Wulff considers to be more succulent than *G. petrense,* is unfortunately not represented in the local garden.

The chromosomes are small and show no appreciable differences in size or structure within the complements. A slight variation in size occurs between the chromosomes of different species, those of polyploid species usually being smaller than those of diploids. In diploid and tetraploid sectors of the periblem the chromosomes are about equal in size.

In the polyploid species a larger number of actively dividing cells occur than in the diploids. This may mean that growth in polyploids is faster than in diploids, or that cell-divisions in the former take a longer time.

With the exceptions discussed above, this investigation on the chromosome morphology of the genus Gibbaeum bears out Wulff's results.

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